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## DO WOMEN WHO DIED OF CARDIAC DISEASE WITHIN 10 YEARS OF BREAST OR CHEST WALL RADIOTHERAPY VIOLATE THE 'QUANTEC' CARDIAC DVH GUIDELINES?

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**Purpose:** Breast and chest wall irradiation (RT) increase the risk of cardiac death. This increased risk is presumed to be a result of the incidental exposure of the heart to radiation. International guidelines ("QUANTEC") state that for partial heart irradiation a "V25Gy < 10% (2 Gy/fraction) will be associated with a < 1% probability of cardiac mortality" in long-term follow up after radiotherapy. We therefore set out to establish whether or not women who died of cardiac disease within 10 years of breast or chest wall radiotherapy had radiotherapy plans that violated these guidelines. We also assessed the maximum dose of radiation delivered to the left anterior descending (LAD) coronary artery and cardiac volume parameters in these patients on the assumption that the LAD is the critical structure in most cardiac events related to RT.

**Methods and Materials:** A provincial database was used to identify all women < 80 years of age diagnosed with early stage breast cancer who were treated with adjuvant RT to the breast or chest wall between 2002 and 2006. The heart and LAD were retrospectively delineated using a peer reviewed cardiac atlas. A 1 cm radial margin was placed around the LAD to create a PRV. For each dose plan, DVH's for the heart and LAD were calculated and the V25 compared to the current QUANTEC guidelines.

**Results:** Between RT start and June 2015, 76 patients died of a cardiovascular event after breast or chest wall RT. Forty-two of these patients received left-sided irradiation, and 34 right-sided irradiation. For the left sided cases, median time from diagnosis to death was 6.7 years. Later cardiac deaths (> 9 years after diagnosis) were more common for left-sided cases when compared to right-sided cases (38% versus 24%). Radiotherapy plans were available for 31 of the left-sided cases. Eleven cases were treated without CT planning. Nineteen patients received radiation doses of 40-42.56 Gy over 16 fractions, and 12 patients doses of 45-50.4 Gy over 25-28 fractions. The heart V25 did not exceed 10% in any of our 31 left sided cases. Equivalent doses in 2 Gy fractions (EQD2) were calculated from the DVH using  $\alpha/\beta$  2Gy. The average maximum heart dose was 35.7 Gy (SD 16.3). The average maximum dose was 25.6 Gy (SD 19.8) to the LAD and 40.6 Gy (SD 16) to the LAD PRV.

**Conclusions:** This study has shown that the QUANTEC guidelines were not violated in our cohort of patients that died of cardiac disease after left-sided breast RT. As only 38% of patients died later than nine years after radiotherapy it may be that pre-existing cardiac risk factors were a dominant factor for cardiac death as opposed to effect of RT. It remains unclear as to the exact mechanism of increased cardiac mortality as a result of RT, but radiation to the LAD may be more important than the heart V25 in predicting cardiac mortality.

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## THE BREAST LUMPECTOMY CAVITY: DOES MRI IMPROVE DELINEATION?

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**Purpose:** Accurate delineation of the lumpectomy cavity is important for cavity boost and partial breast irradiation. Previous computed tomography (CT) studies showed significant uncertainty in cavity delineation, with conformity indices between 0.31-0.76. Although magnetic resonance (MR) imaging has better soft tissue contrast than CT, previous studies have

reported contradictory results on improvements in inter-observer variability or cavity visualization scores with MR. We investigated the inter-observer variability in cavity delineation using MR compared to CT at baseline and quantified the change in cavity volume between pre-treatment and end-of-treatment MR for patients undergoing whole breast radiotherapy (WBRT).

**Methods and Materials:** Forty-eight patients with breast cancer planned for WBRT underwent CT and MR (T1, T1 fat-suppression (T1fs) and T2) simulation in the supine treatment position prior to radiotherapy, and MR (T1, T1fs and T2) at the end of treatment in the same position. MR images were acquired at 3T on inhale breath hold using T1 (19s), T1fs (19s) and T2 (1 min 21s with 16s per breath). Two observers delineated the cavity on the CT and all MR sequences and assigned cavity visualization scores to the images. The primary endpoint was inter-observer variability, measured using the conformity index (ratio between common and union volumes of a pair of contours by observers). Cavity visualization scores and conformity indices from CT, T1, T1fs and T2 were compared using the repeated-measures analysis of variance (ANOVA) test; differences were determined using the Tukey post hoc test when the p value from the ANOVA test was < 0.05.

**Results:** The mean cavity visualization scores at baseline were 3.14 (CT), 3.26 (T1), 3.41 (T1fs) and 3.58 (T2). The mean conformity indices were 0.65, 0.65, 0.72 and 0.68, respectively. T1fs and T2 MRI sequences (but not T1) improved the cavity visualization score and conformity index compared to CT (all p < 0.01). There were no significant differences in cavity visualization scores or conformity indices between T1fs and T2. At the end of treatment, there were no significant differences in mean cavity visualization scores among T1, T1fs and T2 sequences (3.15, 3.29 and 3.31, respectively; p = 0.20). The mean conformity indices for these T1, T1fs and T2 scans were 0.64, 0.72 and 0.66, respectively; the conformity index for T1fs was significantly higher than T1 and T2 (p < 0.01). The mean cavity volume on T1 and T1fs sequences, decreased from 18cc at baseline to 13cc at the end of treatment, and from 17cc to 11cc on T2 (p < 0.01).

**Conclusions:** T1fs reduced inter-observer variability on both pre- and end-of-treatment scans, and measured a reduction in cavity volume during WBRT. This rapid sequence can be easily used for adaptive boost or partial breast irradiation, especially on MR linear accelerators.

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PATIENTS WITH LOW-RISK BREAST CANCER AND TAMOXIFEN - DO THEY NEED ADJUVANT RADIATION THERAPY- A META-ANALYSIS  
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**Purpose:** The question if old patients with low-risk breast cancer and tamoxifen require adjuvant radiotherapy after breast conserving surgery is still under debate. The results of five randomized trials are now available.

**Methods and Materials:** 3766 older patients with early stage breast cancer and tamoxifen were investigated if they needed radiation therapy after breast conserving therapy. Published hazard ratios and hazard ratios extracted from available survival curves for overall survival (OS) and progression free survival (PFS) were basis of our meta-analysis. Meta-analysis of the effect sizes on PFS was performed using a random effects model based on parameter estimates of log hazard ratios in Cox models and their standard errors. Furthermore overall survival was examined.

**Results:** Additional radiation therapy with tamoxifen did result in an improvement of local relapse (Hazard Ratio: 6.8, 95% confidence limits 4.23-10.93, p = 2.4E-15). There was no significant difference for overall survival.

**Conclusions:** Additional radiation therapy with tamoxifen does improve local relapse in breast cancer patients but not for overall survival.